

REMARKS

Favorable reconsideration of the application is respectfully requested in light of the amendments and remarks herein.

Upon entry of this amendment, claims 1-13 and 49-61 will be pending. By this amendment, claims 1-5 have been amended; claims 14-48 have been canceled; and claims 49-61 have been added. No new matter has been added.

Objections to the Specification

In Section 2 of the Office Action, the Examiner has objected to the Specification. The claims have been amended, thereby obviating the objection. Accordingly, it is respectfully requested that this objection be withdrawn.

§112 Rejection of Claims 1-48

In Sections 3 and 4 of the Office Action, the Examiner has rejected claims 1-48 under 35 U.S.C. § 112, first and second paragraphs. Claim 1 has been amended and claim 14-48 have been canceled, thereby obviating this rejection.

Accordingly, it is submitted that the Examiner's rejection of claims 1-48 based upon 35 U.S.C. §112 has been obviated and withdrawal thereof is respectfully requested.

§ 103 Rejection of Claims 1-3, 14, 25-27 and 38

In Section 5 of the Office Action, the Examiner has rejected claims 1-3, 14, 25-27 and 38 under 35 U.S.C. §103(a) as being unpatentable over Van Stralen *et al.* (U.S. Patent 6,304,996 B1; hereinafter referred to as "Van Stralen") in view of Shiu *et al.* (U.S. Patent 6,392,572 B1;

hereinafter referred to as “Shiu”). Claims 1-3 have been amended and claims 14, 25-27 and 38 have been canceled to address the rejection.

In the Background section of the Specification, it was stated that “[BCJR] describes an algorithm for minimizing symbol error rates when decoding predetermined codes such as convolutional codes. ... The BCJR algorithm is designed to output not each symbol but the likelihood of each symbol as a result of decoding operation. Such an outputs is referred to as soft-output..” *Background of the Specification, page 1, lines 14-20*. “However, the BCJR algorithm is accompanied by a problem that it involves a large volume of computational operations because it requires ... directly hold[ing] probabilities as values to be used for computations and employ multiplications. As an attempt for reducing the volume of computational operations, [an article] ... proposes Max-Log-MAP Algorithm and Log-MAP Algorithm (... referred to as Max-Log-BCJR algorithm and Log-BCJR algorithm respectively hereinafter). ... With the Max-Log-BCJR algorithm, the probabilities α_t , β_t and γ_t are expressed in terms of natural logarithm so that the multiplications for determining the probabilities are replaced by a logarithmic addition ... and the logarithmic addition is approximated by a logarithmic maximizing operation ...” *Background of the Specification, page 6, line 17 to page 7, line 10*.

“As pointed out above, since the Max-Log-BCJR algorithm does not involve any multiplications, it can greatly reduce the volume of computational operations if compared with the BCJR algorithm. ... The Log-BCJR algorithm is devised to improve the accuracy of approximation of the Max-Log-BCJR algorithm. More specifically, in the Log-BCJR algorithm, a correction term is added to the addition of probabilities ... so that the sum of the addition ... may represent a more accurate logarithmic value. The correction is referred to as log-sum correction hereinafter.” *Background of the Specification, page 10, lines 2-11*.

“These log-sum correction methods are developed by putting stress on the performance of the algorithm in terms of accurately determining the value of the correction term. However,

they are accompanied by certain problems including a large circuit configuration and slow processing operations.” *Background of the Specification, page 13, line 18 to page 14, line 1 (emphasis added).* “Thus, while various methods have been discussed for the purpose of log-sum correction, all of them still have something to be improved. ... Not only the log-sum correction but also the above described operation of determining the maximum value gives rise to the problem of delay when determining the maximum likelihood path to baffle the efforts for realizing high speed decoding.” *Background of the Specification, page 14, line 19 to page 15, line 3 (emphasis added).*

To address the above-described problems of the conventional decoders in implementing the BCJR technique, embodiments of the present invention provide a capability for the maximum likelihood decoder to provide concurrent computations of log likelihoods through at least two paths selected from at least three paths for both forward and backward state metrics in a Trellis diagram. This configuration provides a faster log-sum correction processing than the configurations implemented in the conventional decoders. For example, the structure of a decoder of claim 1, as presented herein, includes:

“a first probability computing means for computing a logarithm of branch metric (γ), which is a logarithm of probability of a particular branch of a Trellis diagram, computed only based on the knowledge of input and output symbols associated with the particular branch;

a second probability computing means for computing a logarithm of forward state metric (α), which is a logarithm of probability of a particular state of the Trellis diagram, given the probabilities of states at previous time instances;

a third probability computing means for computing a logarithm of backward state metric (β), which is a logarithm of probability of the particular state of the Trellis diagram, given the probabilities of states at future time instances,
wherein each of said second probability computing means and said third probability computing means includes

a path selection means, said path selection means including:

a plurality of comparator circuits,
a plurality of absolute value computation circuits, and
a plurality of selectors to select at least two paths to a state in the Trellis diagram from at least three paths, said plurality of selectors configured to enable concurrent operations of addition, comparison, and selection in log likelihood computations; and

a soft-output determining means for determining a log soft-output logarithmically expressing a soft-output in each time slot, given said forward and backward state metrics as well as said branch metric.”

(emphasis added)

In summary, claim 1 generally recites the elements in Figure 9 with second and third probability computing means including elements of a path selection means illustrated in Figure 27. The path selection means of claim 1 is configured to reduce the delay of the addition/comparison/selection (ACS) circuit in performing log-sum corrections by concurrently performing addition, comparison, and selection operations in log likelihood computations through the selection of at least two paths to a state in the Trellis diagram from at least three paths. See specification, page 59, line 4 to page 60, line 6. Also see specification, page 79, line 18 to page 82, line 16.

By contrast, Van Stralen fails to teach or suggest a decoder including a path selection means configured to reduce the delay of the addition/comparison/selection (ACS) circuit in performing log-sum corrections by concurrently performing addition, comparison, and selection operations in log likelihood computations through the selection of at least two paths to a state in the Trellis diagram from at least three paths.

Further, it was stated in Section 5 that Shiu teaches the use of SISO decoding. Therefore, it is maintained that Van Stralen and Shiu, in combination or individually, fail to teach or suggest all the limitations of claim 1.

Based on the foregoing discussion, it is maintained that claim 1 should be allowable over the combination of Van Stralen and Shiu. Since claims 2-3 depend from claim 1, claims 2-3 should also be allowable over the combination of Van Stralen and Shiu. Claims 14, 25-27 and 38 have been canceled.

Accordingly, it is submitted that the Examiner's rejection of claims 1-3, 14, 25-27 and 38 based upon 35 U.S.C. §103(a) has been overcome by the present remarks and withdrawal thereof is respectfully requested.

§ 103 Rejection of Claims 4, 5, 15-24, 28, 29, and 39-48

In Section 6 of the Office Action, the Examiner has rejected claims 4, 5, 15-24, 28, 29, and 39-48 under 35 U.S.C. §103(a) as being anticipated over Van Stralen and Shiu in view of Benedetto *et al.* (S. Benedetto, D. Divsalar, G. Montorsi, and F. Pollara, Soft-Output Decoding Algorithms in Iterative Decoding of Turbo Codes, TDA Progress Report 42-124, NASA Code 315-91-20-20-53; hereinafter referred to as "Benedetto").

Based on the foregoing discussion regarding claim 1, and since claims 4-5 depend from claim 1, claims 4-5 should be allowable over the combination of Van Stralen and Shiu. Further, it was stated in Section 6 that Benedetto teaches that both Approximation Algorithms 1 and 2 require comparison steps for the absolute value. Thus, it is maintained that Benedetto fails to teach or suggest all the limitations of claims 1 and 4-5. Further, it is maintained that Van Stralen, Shiu, and Benedetto, in combination or individually, fail to teach or suggest all the limitations of claims 4-5. Claims 15-24, 28, 29, and 39-48 have been canceled.

Accordingly, it is submitted that the Examiner's rejection of claims 4, 5, 15-24, 28, 29, and 39-48 based upon 35 U.S.C. §103(a) has been overcome by the present remarks and withdrawal thereof is respectfully requested.

§ 103 Rejection of Claims 6, 9, 10, 12, 13, 30, 33, 34, 36, and 37

In Section 7 of the Office Action, the Examiner has rejected claims 6, 9, 10, 12, 13, 30, 33, 34, 36, and 37 under 35 U.S.C. §103(a) as being unpatentable over Van Stralen, Shiu, and Benedetto in view of XP-000888685 ("Simplified Log-Map Algorithm", Research Disclosure, Kenneth Mason Publications, Hampshire, GC, No. 421, May 1999, Page 612, ISSN: 0374-4353; hereinafter referred to as "XP-000888685").

Based on the foregoing discussion regarding claim 1, and since claims 6, 9, 10, 12, and 13 depend from claim 1, claims 6, 9, 10, 12, and 13 should be allowable over the combination of Van Stralen, Shiu, and Benedetto. Further, it was stated in Section 7 that the reference XP-000888685 teaches that $B=4=2^2$. Thus, it is maintained that the reference XP-000888685 fails to teach or suggest all the limitations of claims 1, 6, 9, 10, 12, and 13. Further, it is maintained that Van Stralen, Shiu, Benedetto, and XP-000888685, in combination or individually, fail to teach or suggest all the limitations of claims 6, 9, 10, 12, and 13. Claims 30, 33, 34, 36, and 37 have been canceled.

Accordingly, it is submitted that the Examiner's rejection of claims 6, 9, 10, 12, 13, 30, 33, 34, 36, and 37 based upon 35 U.S.C. §103(a) has been overcome by the present remarks and withdrawal thereof is respectfully requested.

Newly-added Claims 49-61

Since claim 49 closely parallels, and includes substantially similar limitations as, claim 1, claim 49 should also be allowable over the cited prior art references. Further, since claims 50-61 depend from claim 49, claims 50-61 should also be allowable over the cited prior art references.

Conclusion

In view of the foregoing, entry of this amendment, and the allowance of this application with claims 1-13 and 49-61 are respectfully solicited.

In regard to the claims amended herein and throughout the prosecution of this application, it is submitted that these claims, as originally presented, are patentably distinct over the prior art of record, and that these claims were in full compliance with the requirements of 35 U.S.C. §112. Changes that have been made to these claims were not made for the purpose of patentability within the meaning of 35 U.S.C. §§101, 102, 103 or 112. Rather, these changes were made simply for clarification and to round out the scope of protection to which Applicant is entitled.

In the event that additional cooperation in this case may be helpful to complete its prosecution, the Examiner is cordially invited to contact Applicant's representative at the telephone number written below.

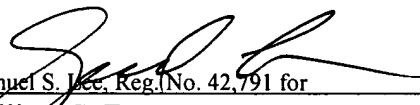
PATENT
Serial No. 09/876,742
Attorney Docket No. 450100-03274

The Commissioner is hereby authorized to charge any insufficient fees or credit any overpayment associated with the above-identified application to Deposit Account 50-0320.

Respectfully submitted,

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